

# REPORT DOCUMENTATION PAGE

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Veon Wendy Civ AFRL/AFOSR

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**From:** Bill Kath [kath@mamba.esam.nwu.edu]  
**Sent:** Tuesday, April 11, 2000 5:08 PM  
**To:** wendy.veon@afosr.af.mil  
**Cc:** n-temkin@nwu.edu  
**Subject:** Re: Overdue Final Technical Report (fwd)

Dear Ms. Veon,

Attached is a copy of the final technical report for AASERT Grant F49620-96-1-0337 which I submitted in the fall.

If you need any additional information please let me know.

Sincerely,

Bill Kath

%%%

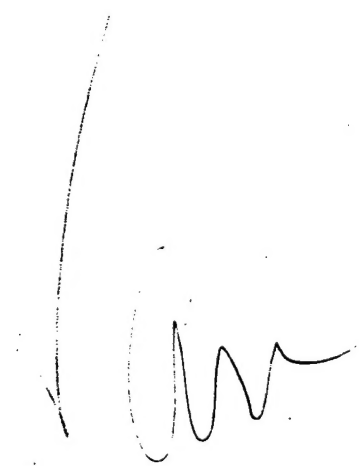
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AFOSR FY96 AASERT Grant F49620-96-1-0337

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Parent Grant:  
The Stability and Dynamics of  
Optical Waveguides, Lasers, and Amplifiers  
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Final Technical Report  
1 September 96 – 31 September 99

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## OBJECTIVES

The goal of this project was to develop mathematical models of new methods for controlling solitons in optical storage loops and optical switching devices. Such control techniques are important for applications involving the generation and processing of high-speed optical bit streams, and devices based upon them can be thought of loosely as basic optical 'circuit elements' for the next generation of high-speed information processing systems. Mathematical methods (singular perturbation methods, including matched asymptotic or multiple-scale expansions, soliton perturbation theory, and the method of averaging) and numerical computations were used to determine the performance characteristics of the devices under consideration. The mathematical models thus obtained were used to determine the best system configurations and to optimize the performance in each case as far as possible.

## STATUS OF EFFORT

Mr. Michael Mills has been supported by this AASERT grant from

September 1, 1996 to August 31, 1998. Mr. Mills used soliton perturbation theory and numerical simulations to investigate the frequency shift imparted on a signal pulse due to control pulse evolution during pulse interaction within the NOLM. His work was written up in a volume of refereed conference proceedings and presented at an international conference. Mr. Mills has since accepted a postdoctoral research position at the Naval Research Laboratory.

Mr. Brian Marks was supported by this AASERT grant from September 1, 1998 to September 31, 1999. Mr. Marks used averaging methods to analyze pulse propagation in fibers with dispersion management (where fibers with different parameters are concatenated together to improve overall system performance).

#### ACCOMPLISHMENTS/NEW FINDINGS

The interaction of two copropagating pulses with different frequencies in a nonlinear optical loop mirror switch can be described using coupled nonlinear Schroedinger equations. Analytic and numerical studies of these equations show that the residual signal pulse velocity shift is strongly affected by the evolution of the control pulse shape during the interaction. The analysis also suggests that prechirping the control pulse before launching it into the loop mirror significantly reduces this effect.

In addition, we have discovered an advantageous dispersion management scheme for wavelength-division-multiplexed soliton transmission, in which optimal launch points are obtained whose locations are independent of the fibers' dispersion parameters. Since using such optimal launch points minimizes dispersively shed radiation, it is therefore possible to simultaneously optimize the transmission in several different channels. For the particular case of a two-step dispersion map, we have shown this result can be achieved by properly choosing the fiber lengths. We have also used the models to optimize the placement of the amplifiers in such dispersion maps.

Publications describing the details of both of these results are still in preparation.

#### PERSONNEL SUPPORTED

##### \* Graduate Students

Mr. Michael Mills  
Mr. Brian Marks

##### \* Other (please list role)

#### PUBLICATIONS

##### \* ACCEPTED

##### \* Conferences

Dispersion maps with optimized amplifier placement for wavelength division multiplexing, Conference on Optical Fiber Communications, Baltimore, MD, February, 2000, to appear.

##### Refereed:

Frequency shifts in a nonlinear optical loop mirror switch induced by control pulse spreading, in "Mathematical and Numerical Aspects of Wave Propagation", J. A. DeSanto, Ed., 1998, SIAM (M. J. Mills and W. L. Kath).

Dispersion maps with amplifier placement optimized for massive WDM, European Conference on Optical Communication Technical Digest, Vol. 1

(1999), pp. 400-401 (with B. S. Marks and S. K. Turitsyn).

Unrefereed:

#### INTERACTIONS/TRANSITIONS

\* Participation/Presentations At Meetings, Conferences, Seminars, Etc

``Frequency shifts in a nonlinear optical loop mirror switch induced by control pulse spreading," SIAM Conference on Mathematical and Numerical Aspects of Wave Propagation, Golden, Colorado, June 1998.

``Dispersion maps with amplifier placement optimized for massive WDM," European Conference on Optical Communication, Nice, France, September 1999.

``Multiple-scale averaging and optimum amplifier placement in multi-channel dispersion-managed soliton transmission," Fifth SIAM Conference on Applications of Dynamical Systems, Snowbird, Utah, May 1999.